MICROWAVE ASSISTED SWITCHING BEHAVIOR OF COCRPT BASED GRANULAR MEDIA

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I. INTRODUCTION

Microwave assisted magnetic recording (MAMR) is one of the candidate technologies to realize further recording density [1]. It is important to understand behavior of microwave assisted switching (MAS), in which switching field is reduced by radio-frequency (rf) field with GHz frequency range. The behavior of MAS has been extensively studied in various systems experimentally as well as theoretically. Analytical and numerical studies based on the macrospin model have predicted that the switching field linearly decreases with increase of rf field frequency (f_{rf}) up to the critical frequency, at which assistance effect suddenly vanishes [2,3]. Experimental results on isolated nanodots follow the prediction very well, suggesting that the MAS behavior in isolated structures can be well described by the macrospin model [4]. On the contrary, experimental results reported on CoCrPt based granular media show different tendency, for instance smaller assistance effect and broader frequency dependence compared to the macrospin model [5]. Recently we have reported that MAS effect in granular media shows strong field amplitude dependence, and the coercivity reduction ratio reaches about 50 % by applying rf field with amplitude close to 1 kOe. In this work we present experimental results on MAS behavior on CoCrPt based granular media with linearly polarized rf fields.

II. Experimental Details

A gold line of 1.0 μm in width and 100 nm in thickness for rf field application was fabricated on top of a MgO substrate. The gold line was designed to be shorted co-planar wave guides structure with 50 Ω impedance to minimize insertion loss. After depositing a SiO_2 layer of 100 nm in thickness for insulation, a CoCrPt-TiO_2 granular medium was deposited with a capping layer and underlayers. The total film structure is Pt(2)/CoCrPt-TiO_2(15)/Ru(10)/$[Pt(5)/Ta(2)]_5$. The numbers in parenthesis expresses thickness of each layer in nanometers. The granular media layer was etched into a rectangular shape of 1.0×3 μm^3, and the etching process was stopped in the middle of the Ru underlayer. The partially etched underlayer was patterned into a cross shaped electrode for anomalous Hall effect (AHE) measurement. In-plane linearly polarized magnetic field was generated by applying rf pulsed current with frequency f_{rf} = 3 – 25 GHz to the gold line. The maximum field amplitude was evaluated to be 950 Oe at the sample position. The rf field pulse width was fixed as 20 ns to minimize heating effect due to Joule heating. The rf field pulse period was set to be 20 μs. All AHE curves were measured by detecting AHE as a function of dc field along film normal.

III. Results

Figure 1 shows normalized AHE voltage curves of CoCrPt-TiO_2 granular media measured without rf field and with rf field of 18 GHz in frequency. Coercivity drops from 4.7 kOe to 2.4 kOe by applying rf field, without significant change of the slope of the curves. Figure 3 is contour plot of normalized AHE voltage plotted as functions of H_{dc} and f_{rf}. The contour plot was created with a series of AHE curves measured with dc field swept from -15 kOe to +15 kOe, and fixed f_{rf}. Coercivity, which corresponds to center of the white band in the plot, linearly decreases with increase of f_{rf} up to f_{rf} ~20 GHz. The width of

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the white band is almost constant, indicating that the slope of the AHE curve does not show strong rf frequency dependence.

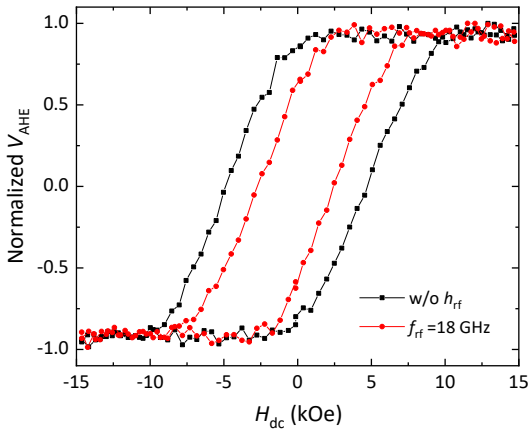

Fig. 1 Normalized anomalous Hall voltage curves measured without rf field and with rf field of f_{rf} = 18 GHz.

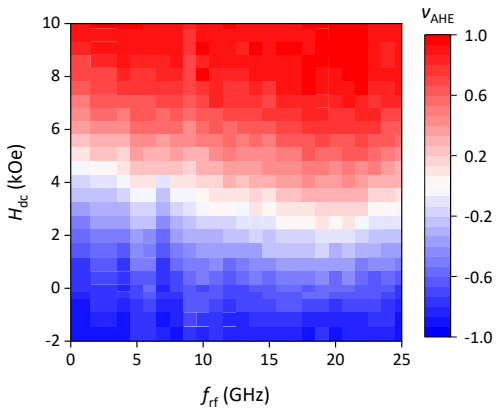

Fig. 2 Contour plot of normalized anomalous Hall voltages v_{AHE} as functions of rf field frequency f_{rf} and dc field H_{dc}. v_{AHE} was measured with fixed f_{rf} and H_{dc} swept from -15 kOe to +15 kOe.

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